

Arctic Dreams – A Reality Check

Large deposits of oil and gas await development and discovery above the Arctic Circle. The harsh environment and remoteness of the region will challenge both the technology and economics to exploit these resources.



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Early 17th and 18th century explorers dreamed of finding a faster trade route to the Orient, the fabled Northwest Passage. Names like Davis, Baffin, Hudson, Peary, Franklin and Amundsen come to mind. Each subsequent expedition pushed farther and learned more about the vast region. Finally, in 1906, taking 3 years to complete the journey, Norwegian Roald Amundsen became first to sail through the Northwest Passage and past northern Alaska.

The Arctic shelf represents an immense, frontier area for oil and gas exploration.

The Arctic is warming rapidly. There is less ice now, and the ice cover is predicted to get much thinner and cover less area in the near future. The prospect of more ice free waters, the ever increasing demand for energy resources, and new technologies have oil and gas companies, and the countries adjoining the Arctic, dreaming of exploiting and finding more huge deposits of oil and gas in the region. Like the explorers that came before, it will take years of persistence and patience to be successful.

Successful Exploration

To date, around 550 oil and gas fields have been found in the Arctic basins. The area also boasts several world class petroleum provinces, namely northern Alaska, East Barents Sea, and the South Kara/Yamal basins. The Arctic oil and gas fields represent discovered resources (according to an IHS study) exceeding 350 Bboe (56 Bm³) or about 15% of the world's known discovered hydrocarbon reserves. The largest field yet discovered with about 70 Bboe (11 Bm³) is the Urengoykoye field, the second largest gas field in the world. At 17 Bb recoverable oil (2.7 Bm³), Prudhoe Bay in northern Alaska is the largest oil field yet discovered in the Arctic.

Even with these successes, most of the region's basins remain untested and only moderately explored. This issue of Geo ExPro takes a look at Arctic exploration and potential. Highlighted are Arctic Alaska and the Laptev Sea. The Barents Sea was discussed at length in v.2, no. 1 (2005; www.geoexpro.com/exploration).

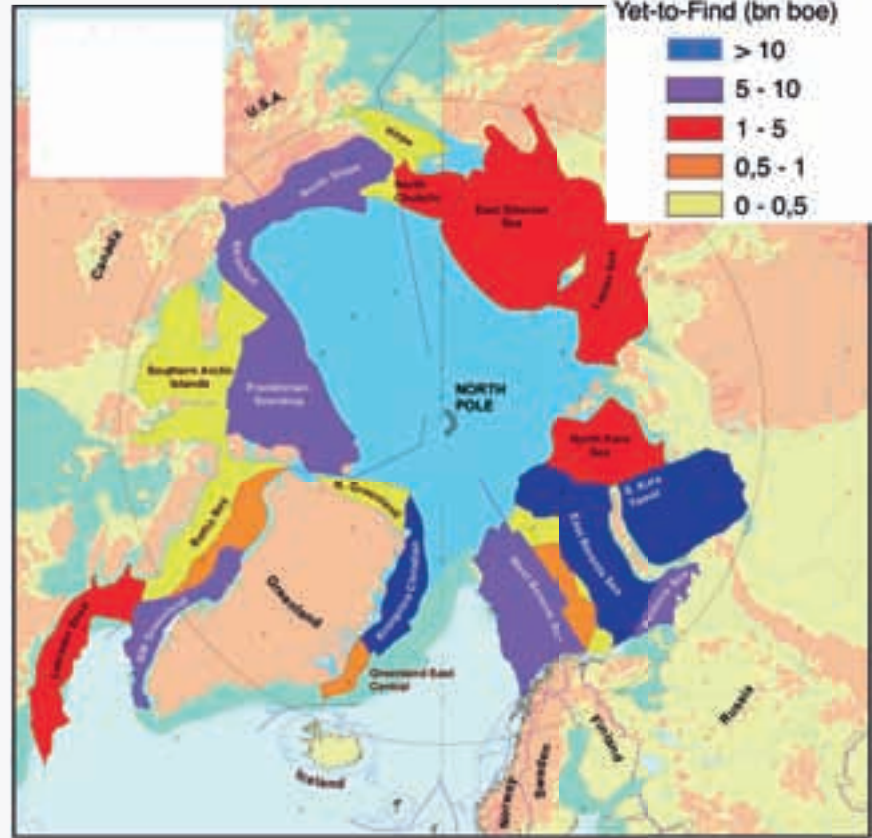
Resource Estimates

The United States Geological Survey (USGS) has been doing resource assessments for over 30 years. Their assessments result from "tried and true" methodology applied by a team of experts (Geo ExPro v. 4, no. 2, p. 68). The USGS World Petroleum Assessment 2000 gave resource estimates for portions of the Arctic. Dr. Donald Gautier of the USGS, was a participant in this evaluation and claims "the 2000 World Assessment was not focused on the Arctic, rather it included just 6 provinces that extended above the Arctic Circle. Each province had a very large range of uncertainty. For example, the South Kara estimates had a range of 1 to 11 Bbo (0.16 to 1.7 Bm³) and 140 to 490

Tcf (4 to 14 Bm) gas. Other provinces had similar uncertainties. However, if you take the mean values from the Arctic area of the 6 provinces, you arrive at 237 Bboe (38 Bm³) or about 14% of the world's undiscovered resources. A large percentage of these

resources are gas."

The USGS is in the process of a new Arctic assessment. Donald Gautier says "the Arctic assessment that will be released in August next year will be comprehensive, evaluating over 100 provinces. The Arctic

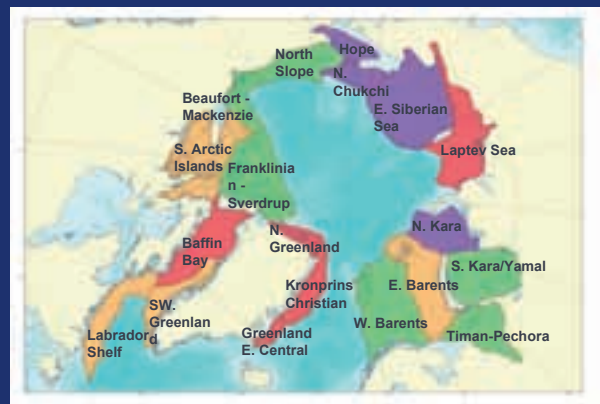


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Three basins in the Wood Mackenzie study, East Barents Sea, S. Kara/Yamal, and Kronprins Christian, are predicted to contain most of the undiscovered resources in the Arctic.

Subsurface data quality varies widely by basin

- Extensively published and drilled, good seismic coverage possibly including prospect maps.
- Well published, some field/well data and moderate seismic coverage.
- Moderate to poorly published, minimal well data with moderate seismic and outcrop data.
- Poorly published, effectively undrilled with limited seismic and outcrop data.



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Data quality varies greatly from basin to basin across the Arctic.

Petroleum Systems will be classified and full-cycle resource analysis will be modeled. Assessment techniques in unexplored basins will be based upon geologic synthesis and analog modeling."

Wood Mackenzie and Fugro-Robertson recently completed a subsurface and commercial review of the discovered resources and the yet-to-find potential in the Arctic region. They factor in the existing infrastructure, cost environment, and full cycle economics in an attempt to predict future production from the region. Their estimates rely on drilling and production data from energy firms working in the Arctic.

Their study is in contrast to past U. S. Geologic Survey (USGS) assessments of different Arctic regions. The Wood Mackenzie report estimates about 178 Bboe (28 Bm³) across five countries in the Arctic. Approximately 74% of that is gas. They place 6 Bboe (1.0 Bm³) in Arctic Alaska, while the USGS mean is 50 Bbo (8.0 Bm³) and 227 Tcf (6.4 Bm³) gas. Dr. David Parkinson, an upstream consultant for Wood Mackenzie, said "our resource estimates differ from those done by the USGS, in that the approach we use builds up play by play estimates to give the resources that can be expected to be recovered over time".

Differences Across the Arctic

The recent Wood Mackenzie and Fugro-Robertson study, "Future of the Arctic – A New Dawn for Exploration," points to the huge differences across this enormous frontier.

"It is these differences that require companies to incorporate different strategies to exploit the opportunities the Arctic offers," says David Parkinson. "For example, Arctic Alaska, South Kara/Yamal basins of Russia, and the East and West Barents basins in Norway and Russia contain large discovered resources. Arctic Alaska and the South Kara/Yamal basins have infrastructure in place and pipeline links to markets. In the case of Arctic Alaska, more exploration is taking place because of excess capacity in the Trans Alaskan Pipeline System (TAPS). A gas pipeline is in the planning stages to exploit the area's large gas reserves. Then there are the basins with little or no data, no infrastructure, and a long way from established industry hubs and infrastructure. While basins like the East Siberian, North Chukchi, Laptev Sea, and North Greenland may have large



Massive new infrastructure will have to be built to bring resources to market.

potential resources, thick pack ice and the sheer remoteness of these areas will make exploration and exploitation challenging."

Opportunities

"Because of different challenges and economics across the Arctic, we see distinct opportunities for companies, namely major resource capture, niche operations, and frontier exploration," explains David Parkinson.

Major resource capture will require gaining access to large volumes through licensing rights and access in a highly prospective, yet under explored basin. The supermajors will be best suited to develop such projects that require huge investments and innovative subsea and extended reach drilling technologies. The offshore portions of the South Kara/Yamal and East Barents basins are two areas where companies can gain access to large resources. Both areas have a large undeveloped resource base and with an estimated 126 Bboe (20 Bm³) yet to be discovered offer the best opportunities for large discoveries.

Niche operations involve exploration

close to existing infrastructure where a company can develop a competitive advantage to generate higher returns than a competitor. One example of this would be the North Slope of Alaska. The area to date has been dominated by 3 companies, who are continuing to tie smaller fields into existing infrastructure. With excess capacity of the TAPS and availability of rigs and personnel, new areas are being explored. Other areas that meet the criteria are the Pechora Sea in Russia with the development of the Piraziomnoye field, and the West Barents with the development of the Snøhvit field off northern Norway. Once the Mackenzie Valley Pipeline is built, anchored by large gas reserves in the Mackenzie Delta, Canada, there will be the opportunity for more gas exploration in that area and companies are already positioning for the eventuality.

Frontier exploration means starting from scratch. Many of the frontier basins have little or no seismic data and there are difficulties obtaining exploration licenses. Obtaining seismic data will require either ice breaker support or summer operations only where the ice pack allows. Drilling will be expensive in these remote areas ▶



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Many areas will require technology to withstand the extremes of the Arctic.

which all add up to large upfront costs. "The frontier basins we consider that have the highest yet-to-find potential are the Kronprins Christian basin to the east of Greenland, the Southwest Greenland basin, and the Laptev Sea which lies north of Eastern Siberia," says David Parkinson.

Common Threads

While there are many differences that require companies to be flexible in order to exploit the area, the Arctic could also have some common links that may provide valuable information into the petroleum systems. Just as the present day Arctic is

becoming warmer from a very cold recent past, there were other times when the climate was balmy. For example, about 55 million years ago, the region had palm trees and crocodiles.

Over geologic time, source beds from condensed sections, many deposited



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New source beds and petroleum systems remain to be discovered in the Arctic.

during episodes of a much warmer Arctic, may provide key links across the Arctic. The Triassic Shublik Formation and the Cretaceous-Tertiary Hue Shale were the focus of Arctic Alaska exploration. However, the rocks that sourced the giant Prudhoe Bay field are not present or have been destroyed by deep burial in other parts of the Arctic.

Discovered in 1994, the Alpine field in Alaska was found to contain oil sourced solely from the early Jurassic Kingak Shale. This petroleum system is now the focus of exploration to the east of Prudhoe Bay and, according to David Houseknecht of the USGS, this system may extend into the Chukchi Sea and possibly around other parts of the Arctic. Another possible source rock, which may be present beneath parts of the offshore Arctic, is the Turonian (Upper Cretaceous) Seabee Formation.

Tertiary oils have been discovered in the Mackenzie Delta of Canada and offshore the Arctic National Wildlife Refuge, Alaska. However, exploration drilling has not penetrated a source rock from which these


oils may have been generated. A possible source rock may have been found in 2004 by the Integrated Ocean Drilling Program (IODP) that recovered 400m of core from the Lomonosov Ridge that bisects the Arctic Ocean. This ridge is a high-standing, narrow sliver of European continental crust that rifted away in the early Tertiary. The cores contain a Paleocene to early Eocene organic-rich condensed section. Within this condensed section is the Azolla horizon (see separate article in this issue). Indications show this condensed section was deposited during another episode of warmer global temperatures that was much higher than today's.

"The recovery of thick source rocks on Lomonosov Ridge, some of which are oil-prone, together with tectonic reconstructions that indicate the Arctic Ocean reached its present configuration in the early Cretaceous, are positive indications that Paleocene to Eocene source rocks may be present beneath the entire Arctic Ocean – including beneath the thick wedges of Tertiary sediment

deposited along the margins of the Arctic Ocean," says David Houseknecht of the USGS.

Arctic Surprises

David Parkinson reminds us that "the Arctic should not be considered a single frontier for the oil and gas industry. Each area will have a unique set of challenges that require unique solutions. It will continue to be a difficult environment for oil and gas companies to prosper. However, understanding the differences across the Arctic basins will allow companies to take advantage of its resource potential."

Donald Gautier agrees with David Parkinson, saying "The Arctic is a different place to explore. While our information on the region is expanding exponentially, we are faced with extreme geological and technical uncertainty. Pervasive high costs will persist and future surprises, both good and bad, are a certainty." 

White Mountains, Yukon Territory of northwestern Canada.



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